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T AND E GUIDELINES FOR MISSILE WEAPON SYSTEMS

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T&E GUIDELINES FOR MISSILE WEAPON SYSTEMS

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FOREWORD

This report is an outgrowth of the work of the Defense Science Board Task Force on Test and Evaluation, and the checklists herein have been derived from the study of past major weapon system programs.

The T&E expert in reading this volume will find many precepts which will strike him as being too obvious to be included in checklists of this type. These items are included because examples were found where even the obvious has been neglected, not because of incompetence or lack of personal dedication by the people in charge of the program, but because of financial and temporal pressures which forced competent managers to compromise on their principles. It is hoped that the inclusion of the obvious will prevent repetition of the serious errors which have been made in the past when such political, economic and temporal pressures have forced project managers to depart from the rules of sound engineering practices.

In the long run, taking short cuts during T&E to save time and money will result in significant increases in the overall costs of the programs and in the delay of the delivery of the corresponding weapon systems to the combatant forces.

T&E GUIDELINES FOR MISSILE WEAPON SYSTEMS

The checklist items presented here are specifically applicable to missile testing and evaluation. It is suggested that the user of this volume also refer to the Report of the Defense Science Board on Test and Evaluation which contains general checklist items also applicable to this system T&E program. The checklist items presented here are organized into time phases of the acquisition process oriented to the DSARC cycle.

The checklists cover various aspects of the major activities that should be underway during a given time period. Hence, a checklist might cover the (1) evaluation of work that occurred in the previous phase, (2) conduct of tests planned in the previous phase and executed in the subject phase, and (3) plans and other preparatory actions for test schedules to be conducted in a subsequent phase. For reasons such as this, items on some subjects, such as development test plans, may appear in more than one phase. In addition, since the Services and the DSARC have flexibility in deciding how rapidly to progress in the validation phase, there may be cases where the Request for Proposals (RFPs), proposal evaluations, source selections, or contract negotiations may occur after the DSARC approves full-scale development instead of before. For this reason, it is recommended that previous checklists in the Validation Phase be reviewed when entering the Full-Scale Engineering Development Phase. The following are the phases used in this report.

CONCEPTUAL PHASE

The checklist items in this phase are for guidance in evaluating T&E activities during the Conceptual Phase of weapon systems acquisition. This phase (often research and exploratory development) precedes the first DSARC milestone and is focused on the development of a weapon system concept that offers high prospects of satisfying an identified military need.

Although not called for in DoD Directive 5000.1 specifically, the objectives of this phase should be:

1. To verify that there is a military need for the proposed system.
2. To demonstrate that there is a sound physical basis for a new weapon system.
3. To formulate a concept, based on demonstrated physical phenomena, for satisfying the military need.
4. To show that the proposed solution is superior to its competitors in terms of potential effectiveness, probability of success, probable cost, impact on the U.S. military posture, and development risks.
5. To analyze the technology outlook and the military need to show that it is better to start advanced development now rather than to wait for future technological improvements.
6. To identify the key risk areas and critical issues that need to be resolved before full-scale development is initiated.

The most important product of this phase is the Development Concept Paper (DCP) or its equivalent. The DCP defines program issues, including special logistics problems, program objectives, program plans, performance parameters, areas of major risk, system alternatives, and acquisition strategy.

VALIDATION PHASE

The checklist items in this phase are for guidance in conducting T&E during the Validation Phase (the time between when the DSARC recommends approval of the DCP for the first time and when the DSARC recommends full-scale development of the system).

While these objectives are not spelled out in the DoD Directive 5000.1, the objectives of the Validation Phase should be to confirm:

1. The need for the selected system in consideration of the threat, system alternatives, special logistics needs, estimates of development costs, preliminary estimates of life cycle costs and potential benefits in context with overall DoD strategy and fiscal guidance.
2. The validity of the operational concept.
3. That development risks have been identified and solutions are in hand.
4. Realism of the plan for full-scale development.

In the pursuit of the above objectives, it is likely that advanced development T&E will be conducted to resolve issues. In some cases, an RFP for full-scale engineering development will be prepared, proposals will be received and evaluated, and contracts negotiated in preparation for seeking DSARC approval for the next phase. Therefore, some checklist items are included to help ensure that this work properly reflects the T&E interests in this and subsequent phases. For example, the RFP must include adequate guidance to ensure that sufficient resources and time are available so that engineering effort can properly support the initial DT&E with hardware, software, technical data, and training.

The primary emphasis of OSD/T&E activities is with items 3 and 4 above. Special attention should be given to the planning of IOT&E activity as it is incorporated in the engineering development contract as well as the DT&E associated with addressing the critical issues and areas of major risk identified in the DCP.

FULL-SCALE ENGINEERING DEVELOPMENT PHASE

The checklist items contained in this phase are for guidance in conducting T&E during the Full-Scale Engineering Development Phase. This includes the major DT&E and the IOT&E conducted prior to the major production decision. By this time, the weapon system is well-defined and is becoming a unique item and, hence, sound judgment must be applied in using these checklist items.

To enter the Engineering Development Phase, the DSARC will have:

- Confirmed the need in consideration of the threat, alternatives, logistic needs, cost, and benefits.
- Identified development risks.
- Confirmed the realism of the development plan.

Given the above, the primary objectives of the DT&E should be to:

1. Demonstrate that the engineering and design and development process is complete and that the design risks have been minimized (the system is ready for production).
2. Demonstrate that the system will meet specifications.

The primary objectives of the IOT&E should be to:

3. Assess operational suitability and effectiveness.

4. Validate organizational and employment concepts.

5. Determine training and logistic requirements.

In addition, the validity of the plan for the remainder of the program must be confirmed by the DSARC before substantial production/deployment will be recommended to the Secretary of Defense.

The level of OSD/T&E activity is highest during this phase. The IOT&E plan must be designed, the tests conducted, and the data analyzed to evaluate the inputs associated with the primary objectives. These tests should not be conducted until the primary objectives of the DT&E have been met. Thus, OSD/T&E activity is required to assess that the DT&E major milestone--the system is ready for production--has been achieved. Close monitoring of the T&E Service activity is required during the latter stages of this phase.

SUBSTANTIAL PRODUCTION/DEPLOYMENT PHASE

The checklist items contained in this phase are for guidance in conducting T&E after the substantial production decision has been made by the DSARC. This includes DT&E and follow-on OT&E to be conducted on early production items.

To enter the Production/Deployment Phase, the DSARC will have reviewed the program to confirm:

- The need for the system.
- A practical engineering design with adequate consideration of production and logistic problems is complete.
- All technical uncertainties have been resolved and operational suitability has been determined by T&E.
- The realism of the plan.

The primary objective of the DT&E in this phase should be to:

1. Verify that the production system meets specifications.

The primary objectives of the follow-on OT&E should be to:

2. Validate the operational suitability and effectiveness.

3. Optimize organization and doctrine.

4. Validate training and logistic requirements.

At this point, the OSD/T&E activity is similar to that in the previous phase; however, much of the testing is verification that the production system performance is as expected. Hence, most of the items in the previous phase are appropriate to this phase, especially those related to OT&E.

I. CONCEPTUAL PHASE

During this phase the program is being conceived and the DCP is being prepared. The test and evaluation checklist covers consideration of the following:

1. Weapon System Interfaces
2. Number of Test Missiles
3. T&E Gap
4. Feasibility Tests
5. Evaluation of Conceptual and Validation Tests
6. Joint Testing Plans
7. Nuclear Weapons Effects
8. Test Facilities and Instrumentation Requirements

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1. WEAPON SYSTEM INTERFACES

Consider significant weapon system interfaces, their test requirements and probable costs at the outset of the Conceptual Phase.

Ensure that the program plan assembled before DSARC I includes an understanding of the basic test criteria and broad test plans for the whole program. These should include time and costs required for testing system interfaces. Initial program plans sometimes have not anticipated the need for adequate testing. For example, at least one program tested the flight article for an extended period of time before actually launching it from the operationally-configured launcher. The operationally-configured launcher/missile system revealed unexpected interactions which were so different from the original design intent that modifications were required and much of the testing had to be repeated. In another case, late selection of a new avionics suit for the carrier/aircraft made it impossible to define the missile/aircraft interface at the start of the fixed price contracts. This led to several design interactions to make the interface work correctly.

2. NUMBER OF TEST MISSILES

Ensure that there is sufficient time and a sufficient number of test articles to support the program through its various phases.

Compare the program requirements with past missile programs of generic similarity. If there is substantial difference, then adequate justification should be provided. The DT&E period on many programs has had to be extended as much as 50 percent. Has the new program provided reasonable time to analyze difficulties and failures before the following test? Two of the major problems in test programs have been:

(a) Insufficient sample size, not only of complete missiles but also of subsystems, components and piece parts, to test all modes that stress the system throughout the performance envelope and to develop reliability.

(b) Some significant problems found during development have not been adequately corrected prior to production, apparently because of insufficient time or the unavailability of test articles.

There must be sufficient time and resources put into the early planning for the operational tests, particularly the IOT&E phase, because the production and deployment decision is planned to be made based upon IOT&E results. Correspondingly, later in the program, one should not lose sight of the continuing need for adequate test articles. In the past, for example, there have been cases of unanticipated multi-azimuth launch requirements which necessitated additional testing.

Requalification of piece parts and assemblies has also frequently been required for many reasons. This results in a need for additional testing. Again, in many cases there has been insufficient time allowance in a test program to permit proper correction of items which have caused failures.

Experience has shown that there has been a marked tendency to be over optimistic in planning time and resources for test.

There have been circumstances where, for various reasons, the technology has had to be pushed rapidly; the higher risks involved have required more thorough testing and/or greater resources. These programs, typically, have been extended to longer times.

3. T&E GAP

Encourage actions to eliminate or minimize any test and evaluation gap.

A test and evaluation gap has been experienced in some missile programs between the time when testing with R&D hardware was completed and the time when follow-on operational suitability testing was initiated with production hardware. This gap has been as long as 2 years. The gap was generally caused because all available R&D hardware was expended in DT&E and early operational testing. Following this a production decision was made and production hardware was not available for many months. The initial production hardware was first needed for several months of unit training of the operational organization. Finally, the production system operational suitability flight tests were begun. By that time, in one case, the production program had reached maximum rate.

The problems associated with the test and evaluation gap are:

(a) Deficiencies that show up in the operational hardware may be very costly to correct if the production program has been accelerated.

(b) Time is lost during which no system flight experience is gained to further shake-down the system or to learn to use the system tactically.

(c) Fixes developed late in the R&D program cannot be flight tested in a timely manner.

(d) The production team phases down after building R&D items and later builds up again for the production effort. This is a costly process.

(e) The military personnel who gained experience in the IOT&E tend to be lost to the follow-on OT&E due to the time factor and the personnel turnover problem.

Some ways in which a program can be designed to minimize the T&E gap effects are to:

(a) Plan use of production engineering inputs early in the initial R&D design to facilitate later production.

(b) Plan to continue IOT&E to bridge the gap between completion of the usual IOT&E performed with R&D hardware and the start of follow-on OT&E on full production hardware. A quandary in initial operational suitability testing is that, on one hand, Congress is reluctant to approve production until IOT&E is complete, and on the other hand, IOT&E may not be meaningful unless it is conducted with production-like missiles. Therefore, unless low rate pilot production hardware is available for IOT&E, the evaluators must carefully define the hardware that is used to conduct the IOT&E. In some cases, handbuilt R&D type hardware used for IOT&E may be of different quality material than could be expected from mass production.

4. FEASIBILITY TESTS

Ensure experimental test evidence is available to indicate the feasibility of the concept and the availability of the technology for the system development.

Experimental evidence should be available to provide for an evaluation of the proposed concept and the alternative approaches for accomplishing the prime mission of the new system. For example, if propulsion state-of-the art is inadequate for the job, a program in the propulsion area should be conducted in the Definition Phase. There is ample evidence where well executed experimental test programs to prove feasibility were the key to new and successful system developments. Where this is not done, there is considerable danger of program failure in pressing the state-of-the-art very far.

5. EVALUATION OF CONCEPTUAL AND VALIDATION TESTS

Results of tests conducted during the conceptual and the validation phases, which most likely have been conducted as avionics brassboard, breadboard, or as modified existing hardware, should be evaluated with special attention.

Tests should be evaluated with attention to items such as the following:

- Scaling laws may invalidate the findings or introduce new technology problems. Model tests will not necessarily scale up or down as expected in missiles launched underwater, in RV motion dynamics or in solid rocket propulsion units.
- The laboratory-type environment in which the hardware was tested may preclude the generation of data needed to validate that the concept and technology approach will be applicable to an operational environment.
- The tests may not include signals and noise sources representative of those that might be expected in an operational environment. Nuclear background is a typical example.

6. JOINT TESTING PLANS

When a new missile development program requires joint testing during OT&E, the test plan should include the type of tests and resources required from other activities and services.

Several weapon systems designed for defense penetration or defense suppression have had inadequate testing and evaluation in relation to their mission objective.

In general, the T&E plan should, as far as possible, include offense/defense engagements representative of those in which the new system is expected to operate. Many programs have not given full attention to this. Offense/defense testing may be addressed in several phases, such as:

(a) Testing against the best simulation of the assumed threat which can be made available, either in the field or in a laboratory.

(b) Testing against advanced U.S. technology which may be representative of a potential threat.

(c) Testing against electronic countermeasures must be investigated. In the conceptual phase the matter of countermeasures must be considered to ensure that the development is sound. During the development, countermeasures are a secondary consideration; however, after the new system is developed, it is necessary to ensure that it can be used in the presence of countermeasures by the use of technical features of the hardware/software or by alternate operating modes or different tactics. Therefore, later phases of OT&E testing should include appropriate electronic countermeasure aspects.

In summary, there is considerable evidence that weapon systems have been less satisfactory under combat conditions than earlier testing promised. Had test plans been more realistic with better field simulations, the results would have been more meaningful. This in turn may demand joint Service involvements.

7. NUCLEAR WEAPONS EFFECTS

The subject of nuclear weapons effects should be addressed in the DCP when relevant.

In some systems, inadequate attention has been given to the fact that they are being designed for possible operation in a nuclear environment. Early design consideration will prevent the incremental time and expense in attempting late remedial action. Experience has shown the importance of giving early attention to nuclear weapons effects and vulnerability. Plans must recognize that all agencies involved in nuclear weapon development and vulnerability (e.g., AEC and DNA) must have early participation.

8. TEST FACILITIES AND INSTRUMENTATION REQUIREMENTS

Before DSARC I the test facilities and instrumentation requirements to conduct tests should be generally identified along with a tentative schedule of test activities.

The capability of the test range and the adequacy of the facilities and instrumentation should be verified; it is also recommended that alternative approaches be examined (e.g., ranges) and the need for instrumentation improvements or changes be identified early in the program. Of prime importance in missile flight testing are the constraints that may be placed on the test because of range and instrumentation limitations. If range and instrumentation factors are found to cast significant doubt on the meaningfulness of the test data because of a lack of operational realism, steps necessary to assure meaningful data should be identified and planned before the plans are included in the DCP.

Targets for short-range missiles warrant specific mention; some missile systems can't be adequately tested without targets that realistically simulate the threat. In some cases, considerable lead time is required to provide the required target support; hence, target requirements to support the tests must be identified early.

II. VALIDATION PHASE

During this phase the program is defined in detail. The major efforts are to conduct tests and evaluation of any issues raised in the DCP and to plan the test and evaluation efforts for the remainder of the program with emphasis on full-scale development and IOT&E. The test and evaluation checklist covers consideration of:

1. Establish Test Criteria
2. Human Factors
3. Instrumentation Diagnostic Capability and Compatibility
4. Provisions for Test Failures
5. Integrated Test Plan
6. Test and Evaluation Requirements
7. Personnel Training Plans
8. T&E Reporting Format
9. Program-to-Program Crosstalk
10. Status of T&E Offices
11. Measurement of Actual Environments
12. Thoroughness of Laboratory Testing
13. Contract Form
14. Government Test Support Commitments
15. Participation of Operational Command

The reader should also review the checklist items in the previous phase since many of them will be applicable during this phase.

1. ESTABLISH TEST CRITERIA

By the end of the validation phase, test criteria should be established so that there is no question as to what will constitute a successful test and what performance is expected.

There are many examples where the objectives of a given test were not adequately defined or the criteria for success delineated clearly in advance. To a high degree, this reduces or even invalidates the value of the test process. Repeat testing necessitated by such actions is not uncommon and is expensive.

The test plans must clearly define the primary and secondary objectives of each test, the test environment, the performance points to be tested, the instrumentation needs, the data collection plan, and the data reduction requirements.

2. HUMAN FACTORS

Ensure that the test plan includes adequate demonstration of human factors considerations.

At an appropriate time in the concept definition or the development phase, the plan should include consideration of the human factor concepts that will be involved in the operational system. Questions of safety, comfort, effectiveness of man-machine interfaces, reaction time, performance under stress, fatigue, the number and skill levels of the personnel required and other related factors must be examined. The inclusion of human factor requirements in early testing is extremely important. This should result in better performance, and a reduction in subsequent redesign and retrofits caused by the introduction of the operator into the system.

For example, retargeting or selection of alternate weapons under battle conditions may be limited by human factors. Early test can bring out deficiencies which may be more readily corrected at that time in the program. The maintainability of any system also is clearly of great importance. Many systems have failed to give early consideration to maintainability and operability from the human factors standpoint with resulting cost and schedule implications as the program nears operational status.

3. INSTRUMENTATION DIAGNOSTIC CAPABILITY AND COMPATIBILITY

Instrumentation design with adequate diagnostic capability and compatibility in both DT&E and IOT&E phases is essential.

There are many examples where instrumentation has been inadequate to determine the actual cause of missile failures. This has been evident with both DT&E and IOT&E hardware. Much of this difficulty can be avoided if planning insists not only on adequate instrumentation provisions, but also on a degree of compatibility between DT&E and IOT&E instrumentation. The compatibility implies that minimum disturbance of the operational mode of the system must be the aim in all cases.

The instrumentation package configuration should be fixed early in the design phase. For this reason, OT&E instrumentation requirements must be specified early in the definition program and the proposed design critically reviewed by the OT&E people.

4. PROVISIONS FOR TEST FAILURES

DT&E and OT&E plans should make provisions for the occurrence of failures.

DT&E and OT&E test plans should include time and resources necessary for investigating test failures and for eliminating the cause of failure before another test flight takes place. As a general rule no major tests should be repeated until the cause of the preceeding failure is understood and corrective action has been implemented. Where this is not possible, the next flight should have instrumentation configured to pinpoint the cause of prior failure.

Test failures have occurred which were not diagnosed before further flight tests were made and the failures repeated. Careful diagnosis and effective remedial action prior to retest is the proper procedure rather than permitting subsequent flight tests assuming that the same failure will not recur.

A percentage of the total tests (sorties, runs, trials, experiments) should be allowed for retesting.

5. INTEGRATED TEST PLAN

Assure an integrated system test plan that pre-establishes milestones and goals for easy measurement of program progress at a later time.

In an R&D program some failures may be expected, but the plan should be structured to generally ensure that:

(a) Repetitive failure will be held at an absolute minimum and each substantive failure will be analyzed and the cause corrected before subsequent flight tests.

(b) The schedule will accommodate problems.

(c) There is a clear statement of objectives for each test.

(d) The number of tests that are expected to yield an answer have been identified.

(e) Qualification testing of components and subsystems should occur at the earliest possible time in the program. Where existing technology is involved, qualification can usually occur prior to the onset of flight testing. Where advanced technology is involved, qualification should be introduced just as soon as practicable in the development flight test program--but in all cases before production of operational hardware is undertaken. Component or subsystem problems that are detected at the full system flight test level are extremely costly.

(f) Clear, well-defined milestones for review and commitment to the next test phase have been defined.

Almost without exception, every missile program has experienced flight test failures or anomalies. The degree to which corrective action has been taken prior to additional flight tests has varied extremely among various programs. The motivation for continuing flight test without adequate failure diagnosis and corrective action is often associated with:

(a) The desire to claim that the program has completed its major milestones.

(b) Failure to clearly identify test objectives.

(c) A superficial conclusion that the failure was random.

(d) Flying of unqualified components which should have been qualified before flight.

6. TEST AND EVALUATION REQUIREMENTS

Ensure that the test and evaluation program requirements are firm before approving an R&D test program.

Many missile programs have suffered severe cost impacts as a result of this deficiency. The test plan must include provisions to adequately test those portions of the operational envelope which stress the system including backup and degraded operational modes. In addition, those resources necessary for failure analysis and corrective action, along with those necessary for weather and appropriate day/night testing as well as those for offense/defense testing must be included.

In some cases, the basic R&D program tested only the most simple flight profile. Later more difficult profiles were used operationally. In other cases, inadequate attention was given to testing the whole system until too late which resulted in late discovery of integration problems and the necessity for expensive redesign and retesting.

7. PERSONNEL TRAINING PLANS

Ensure that adequate training and certification plans for test personnel have been developed.

Errors by test personnel are usually expensive and often cloud the reason for test failures. An independent survey* has shown that lack of availability of qualified personnel was the primary area contributing to test errors in similar new developments. Because of the cost and inherent irreversibility of missile testing, the quality and adequateness of training and certification plans for test personnel is of critical importance.

8. T&E REPORTING FORMAT

Include a T&E reporting format in the program plan.

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*The Role of Testing in Achieving Aerospace Systems Effectiveness, A report prepared by the AIAA Technical Committee on Systems Effectiveness and Safety, January 1973.

Attention must be given to the reporting format in order to provide a consistent basis for test evaluation throughout the program life cycle. Changes in the reporting methods for test configurations and results should be carefully examined to ensure that rapid and accurate reconstruction of this data is possible throughout the program life cycle. It is extremely important to clearly identify the cause of failure and to determine if it is random or general. This can usually only be accomplished if accurate correlation of the system test history is possible.

Some missile programs have used T&E reporting methods which were not adequate to clearly identify incipient anomalies or even past failure modes. In other programs test reporting systems were changed with resulting degradation in the value of trend data or an inability to quickly track and correct generic causes of failure.

9. PROGRAM-TO-PROGRAM CROSSTALK

Encourage program-to-program T&E cross talk.

Test and evaluation problems and their solutions on one program provide a valuable index of lessons learned and techniques for problem resolution on other programs. This is especially useful in programs employing similar technologies. A strong, intentional and well-organized effort to increase cross fertilization would prevent unnecessary re-identification of the problems and the cost of re-learning their solutions.

As an example, hypergolic propellant usage matured on one program can be transferred with real advantage to guide another program using similar technologies. The same is true for structures, guidance, payload, integration, dynamic response, environmental influence and many other missile subsystems and constraints.

10. STATUS OF T&E OFFICES

Ensure that Test and Evaluation offices have the same stature as other major elements, reporting to the program manager or director.

It is important that the test and evaluation component of the system program office have organizational status and authority equal to configuration management, program control, system engineering, etc. It is essential that data resulting from subsystem and system testing be surfaced and dealt with quickly and effectively. Test organizations which operate subordinate to other program office groups tend to develop the bias of that organization with resulting degradation in objectivity of the test result analysis. It is often the case that the actual test result is a measure of the performance of program control, configuration management, quality control, production and engineering organizations and as such, provides a critical measure of the status of system development and operational use.

11. MEASUREMENT OF ACTUAL ENVIRONMENTS

Thorough measurements should be made to define and understand the actual environment in which the system components must live during the captive, launch and in-flight phases.

For instance, new ballistic missile launch concepts may generate issues to be resolved in the validation phase. These concepts may range from super-hard silos to highly mobile, relatively soft launchers. If testing is necessary to demonstrate one or several launcher concepts, ensure that all significant interfaces of the launcher and the environment are also tested. For example, the cross country mobility may be an issue of an off-road launcher. A test of the launcher concept should, of course, address the major issue, but the test should look further for other relevant information that might surface as a result of a good test. For example, in addressing the initial issue about off-road mobility it may be observed that great dust clouds cause considerable difficulty in maintaining the operability of the instrumentation. This might be a clue regarding reliability of a sophisticated missile guidance system that would require special design consideration.

There are also instances in which the ground and aircraft launching mechanisms or air-to-surface missiles have undergone significant redesign resulting from captive flight and operational launchers measurements, thus indicating the desirability of accomplishing these tests as early as is reasonable in the program.

Prior to the freezing of the production missile design, a thorough inflight measurement program should be conducted so as to provide information on the captive, launch, and in-flight environments of the system. In-flight environments, especially vibration, temperature, shock and stress imposed during the operational use of the missile, should be measured in flight tests and documents.

12. THOROUGHNESS OF LABORATORY TESTING

Significant time and money will be saved if each component, each subsystem, and the full system are all tested as thoroughly as possible in the laboratory.

There are numerous instances in which very expensive retrofits have had to be made on deployed missile systems due to component and subsystem reliability problems which could have been averted through a more thorough test screening or life testing procedure. In addition there are instances in which flight test failures could have been averted by more thorough flight dynamic simulation in the laboratory.

Whenever field testing is expensive compared with laboratory and simulation testing (as in missile or aircraft/missile flight testing), such testing should be conducted primarily for verification of design parameters or design performance, rather than to see whether or not a particular component or subsystem will work. The full system test should be simulated insofar as possible in advance of the flight test. In the case of a tactical missile, for example, captive flight tests, as well as ground and computer simulations, should be conducted.

Other related items are III-8 on test program/range safety dry runs and III-2 on plans and use of test simulations and dry runs.

13. CONTRACT FORM

The contract form can be extremely important to the T&E aspects.

In one program the contract gave the contractor full authority to determine the number of test missiles, and in another the contract incentive resulted in the contractor concentrating tests on one optimum profile to satisfy the incentive instead of developing the performance throughout important areas of the envelope.

In the Validation Phase the contracting strategy is usually established in the RFP and the subsequent evaluation and source selection process. From the T&E standpoint, the contract should:

(a) Permit early user and evaluator participation.

(b) Establish incentives only after careful consideration and resolution of possible undesirable aspects from the T&E standpoint. The incentives should not be based on extreme corners of the theoretical performance envelope unless there is a high operational payoff. On the other hand, the incentive for criteria should not constrain the developer from exploring the likely operational performance envelope.

(c) Facilitate engineering changes resulting from knowledge. gained during the test program and from threat changes.

14. GOVERNMENT TEST SUPPORT COMMITMENTS

Require T&E office coordination for contracts which propose to make government test support commitments.

There are missile programs in which the government committed facility support to a fixed price contract with an "on-demand" provision. The result of this was that the priorities for facility utilization were not consistent with national defense priorities in order to prevent default on the part of the government.

If there are GFE and other government commitments in the proposed contract, be concerned about the following:

(a) Can the gear with required performance be available for test when required?

(b) Can government supported facilities provide the T&E assistance required at the time needed? If not, is it reasonable to construct the required facilities (test range, instrumentation, building, etc.)? If not, what alternatives are available?

(c) Avoid contract terms on fixed price contracts that vaguely commit the government. Do not include "government support as required" or "test facilities will be made available when needed."

(d) Provide test milestones with which to gauge progress and peg decision points to test progress and not to calendar dates;

(e) Provide test resources (R&D, prototypes, pilot production, etc.) for continuous testing activities until the initial substantial production hardware is available.

15. PARTICIPATION OF OPERATIONAL COMMAND

It is imperative that the operational command actively participate in the DT&E phase to ensure that the user needs are represented in the development of the system.

Where user participation in DT&E has been inadequate, additional problems have been discovered when the program progressed to the operational test phase. Some deficiencies discovered late, such as human factors problems, technical manual errors, and design inadequacies, could have been much more easily corrected if they had been found early in the DT&E by user participants.

Initially, the operational test command should plan an advisor role during the feasibility and engineering testing, and finally take over leadership in the conduct of the operational testing program. This user participation in DT&E should facilitate the necessary communication and interaction between the development and the operational commands--especially needed during the DT&E and IOT&E phases.

III. FULL SCALE ENGINEERING DEVELOPMENT PHASE

In this phase the full-scale development and the IOT&E will be planned in greater detail and conducted. The test and evaluation checklist includes consideration of:

1. Production Philosophy and Techniques
2. Operational Flight Profiles
3. Failure Isolation and Responsive Action
4. Responsive Actions for Test Failures
5. Plan Tests of Whole System
6. Determination of Component Configuration
7. Testing of Software
8. Range Safety Dry Runs
9. Assemblies/Subsystems Special Requirements
10. Review of ASM Test Position Fixes
11. Operator Limitations
12. Test Simulations and Dry Runs
13. Component Performance Records
14. Tracking of Test Data
15. Updating of IOT&E Planning
16. Instrumentation Provisions in Production Missiles
17. Constraints on Missile Operator
18. Problem Fixes Before Production
19. Flight Tests Representative of Operations

The reader should also review the checklist items in the previous phases since many of them will be applicable in this phase.

1. PRODUCTION PHILOSOPHY AND TECHNIQUES

Encourage that production philosophy and production techniques be brought into an early phase of the design process for R&D hardware to the maximum extent practical.

There are many missile programs in which the components were not qualified until the missile was well into production. This situation led to a circumstance in which IOT&E test results have less than maximum value and OT&E does not commence until large numbers of units are deployed.

An intimate interaction between production engineers and design engineers, including test personnel, should be established early in the program. This process will tend to minimize the changes between the R&D test hardware and the production units; hence, there is less probability that new problems will show up in the follow-on T&E tests of the produced system. Some programs have done this splendidly and saved much time and money in moving from development to production.

2. OPERATIONAL FLIGHT PROFILES

Tests should be conducted to evaluate all planned operational flight profiles and all primary and back-up degraded operating modes.

The profiles need to be evaluated to ensure that no unpredicated problems occur. For example, some air launched missiles can be programmed to hit targets to the side or the rear as well as to the front, using high altitude or low altitude flight profiles. This results in a large number of flight profile options. The testing should at least cover those planned operational profiles which stress the system.

The backup degraded operating modes need to be tested because aircraft avionics reliability problems and battle damage may cause the primary mode to fail. For instance, a carrier may have several navigation systems such as inertial, doppler, or bomb/nav radar to provide position data for missile inputs. All systems might be used in the primary operating mode. In an operational environment, it is not unlikely that some launches might be made with only one of these systems remaining in operation. Therefore, these backup, degraded operating modes should be tested to determine their characteristics and capability.

3. FAILURE ISOLATION AND RESPONSIVE ACTION

Does the system test plan provide for adequate instrumentation so that missile failures can be isolated and fixed before the next flight.

If failures occur, has sufficient subsystem testing been planned so that the underlying cause of the failures can be properly identified (random failures seldom occur) within the C&C, the propulsion, subsystems, etc.?

After the cause of a failure has been identified and fixed, has it been adequately planned to be demonstrated through subsystem testing that the cause has been removed and that additional failures from that source are unlikely?

As a general rule, do not allow system testing to continue after a failure has occurred unless the above actions have been taken.

4. RESPONSIVE ACTIONS FOR TEST FAILURES

Encourage a closed loop reporting and resolution process which assures that each test failure at every level is closed out by appropriate action, i.e., redesign, procurement, retest, etc.

Sometimes there is reluctance by the design organization to accept that their part failed and to quickly correct design deficiencies discovered in test programs. Tight control, by the SPO, to correct faults discovered in the test program will help ensure that the next test does not fail.

5. PLAN TESTS OF WHOLE SYSTEM

Plan tests of the whole system including proper phasing of the platform and supporting gear, the launcher, the missile, and the user's participation.

There have been missile development programs where important subsystems have not been included in the test program in a timely fashion. In a tactical program, a non-operational launcher was used for testing for many months, when the operational launcher was finally used, redesign and retest was necessary because of the different environmental conditions. The R&D tests should be conducted on the whole system as early as practical.

In other programs, the user participation was either too late or not sufficiently active. The operational evaluation unit personnel should participate in the tests from the beginning and they should act both as active critics and as contributors.

6. DETERMINATION OF COMPONENT CONFIGURATION

Conditions and component configuration during development tests should be determined by the primary objectives of that test.

Whenever a non-operational configuration is dictated by early test requirements, tests should not be challenged by the fact that configuration is not operational. For example, if in the development of a short-range surface-to-surface missile it is found that the test missiles tend to hit the ground early, it may be desirable, for a variety of reasons, to fire the missile from an elevated platform or across a valley before the problems of early missile dropoff are satisfactorily solved. On the other hand, demonstration and acceptance tests, as well as tests intended to evaluate performance under operational conditions, should always be conducted under conditions as close to those anticipated in operations as possible.

Where tests are run with substitute parts, be sure procedures are established to record the fact and ensure that necessary retesting is done with the correct components. When testing is delayed because of the non-availability of critical sub-system components, off-the-shelf interim components may be used as substitutes until the proper components are available. As long as the off-the-shelf components can function acceptably within a defined range of interest, the rest of the system can be tested, thereby facilitating the progress of the test program. Clearly, this cannot be continued indefinitely, but it should serve to reduce the hindering influence of long lead time components that are not available on time. Selected tests may have to be repeated when the proper component is available.

In one system, an autopilot was used in place of the planned inertial guidance system until the latter was ready for incorporation into the system. This substitution permitted testing on the launcher, propulsion, and general flight characteristics.

7. TESTING OF SOFTWARE

Test and evaluation should ensure that software products are tested appropriately during each phase.

Software has often been developed more as an add-on than as an integral part of the overall system. Software requirements need the same consideration as hardware requirements in the Validation Phases. Usual practices often do not sufficiently provide for testing the software subsystem concept. Often the facilities available to contractors for software development and verification are critical to schedule and cost.

8. RANGE SAFETY DRY RUNS

Ensure the test plan includes adequate test program/range safety dry runs.

The government test ranges have to provide facilities to safely test many different projects. All test conducted have a range safety officer responsible for stopping any test that exceeds predetermined limiting conditions. A test program manager should be able to ensure that the range safety equipment and people used on a wet run will be the same as the team used on the dry runs. Programs have experienced numerous aborts and even destruction of good missiles because of problems in the range safety/test interface. These problems usually develop because of incomplete dry runs, range safety communications problems, radar track losses or other dropouts due to equipment changes after the dry runs. Complete dry runs and range cooperation, in holding the range safety teams together for a given project, will help to minimize the problems.

9. ASSEMBLIES/SUBSYSTEMS SPECIAL REQUIREMENTS

Assemblies and subsystems that may require special attention.

There will be selected subsystems or assemblies that usually require special attention.

Seekers and tracking devices especially for automatic systems should receive extensive laboratory testing with use times and environments applied as realistically as possible.

Propulsion subsystems including feed lines and tankage should be dynamically tested at all angles of elevation or positions from the horizon which total vehicle is expected to see in the operational environment.

From the onset of the program special attention should be given to connectors and their related hardware. The design or selection of connectors should be made with their ultimate use in mind. Environmental considerations as well as connect-disconnect frequencies have proven extremely important.

Lanyard assemblies should have extensive laboratory testing. Pull forces should be examined in all angles of the pull cone and these results should subsequently become pull test criteria for the operational system.

Safing, arming, fuzing and other ordnance devices should have complete laboratory work prior to installation in the flight article. It is also suggested that alternate concepts should be considered. Testing should be accomplished for both the preflight and flight environment. Batch or lot testing should be required on all operational hardware.

These items are included in the checklist because they have posed difficult and repeated problems on almost all missile systems. Dealing effectively with this type of hardware early in the program will be cost effective and may prevent major problems from developing in the "all-up systems tests."

10. REVIEW OF AIR-TO-SURFACE MISSILE TEST POSITION FIXES

Review the final position fix planned before launching ASMs.

There are instances in which the operational test of air launched missiles utilized artificial position fixes just prior to missile launch. Optimistic data results, unless the position firing test procedures are similar to those used on operational missiles. System accuracy for inertial guided air-launched missiles will be most dependent upon position, velocity, and heading data provided by the carrier. If the test program uses beacons, radar reflectors or other cooperative accurate fix features in the near vicinity of the target, the accuracy results will be better than could be expected on an operational mission. An operational carrier may have to plan to make the last fix on a prominent feature at a considerable distance from the target due to operational considerations.

11. OPERATOR LIMITATIONS

Ensure operator limitations are included in the tests.

Most tactical missiles, especially those used in close support, require visual acquisition of the target by the missile operator and/ or an air/ground controller. Thus, the system performance is very much dependent upon the operator's eye (or some visual aid). The ability to acquire the target must not be assumed trivial and must be tested in operationally realistic conditions to determine to what extent this factor may limit the capability of the total missile system.

In a normal launch sequence of an E-O type missile, the operator (or pilot, in the case of single place aircraft) is required to (a) locate and acquire the target visually, (b) determine that what he sees is in fact, a real target, (c) decide whether it lies within the size, contrast, and range envelope of the weapon, (d) re-acquire the target on his cockpit display by means of the weapon's seeker, (e) verify that the seeker has achieved "lock" on the proper target, (f) launch the weapon, and (g) maneuver away from the target area. This sequence of activities must be conducted in a dynamic (and very likely hostile) environment; the effect is to make system performance very much dependent upon the operator's ability.

This item is related to Item I-4, ensure that the concept is feasible.

12. TEST SIMULATIONS AND DRY RUNS

Plan and use test simulations and dry runs.

Dry runs should be conducted for each new phase of testing. Simulation and other laboratory or ground testing should be conducted to predict the specific test outcome. The "wet run" test should finally be run to verify the test objectives. Evaluation of the simulation versus the actual test results will help to refine the understanding of the system.

Ground simulation of the electronics system, the flight control and hydraulics system, and the other systems can be most helpful in solving functional, design, safety, maintainability and reliability problems.

Complete system simulation of the planned test can greatly increase the value of overall testing effort by fostering a more complete appreciation of how the system really operates.

Other related items are II-12 on laboratory simulation testing and III-8 on test program/range safety dry runs.

13. COMPONENT PERFORMANCE RECORDS

Keep performance records on components.

There are many examples in missiles programs which have required stock sweeps that are associated with flight failures and aging testing programs. These stock sweeps can require component lot identification, manufacturing time interval, batch processing lot identification, etc.

When developing, testing and evaluating the various subsystems (and systems) of missile weapon systems, each component of the systems should be numbered and a performance history kept which allows an analysis of that component's performance, with respect to reliability, maintainability, availability, etc.

14. TRACKING OF TEST DATA

Ensure the test program tracks data in a readily usable manner.

Reliability and performance evaluations of a missile system should break down the missile's activity into at least the following phases:

- Pre-launch including captive carry reliability
- Launch
- In-flight
- Accuracy/fuzing

Computation of the appropriate reliability data on this basis should provide more insight into test results than more aggregated, less revealing indices.

In monitoring test progress use reliability data carefully. In constructing reliability data, moving averages for recent tests as well as overall averages should be computed, especially when large numbers of tests are involved. This helps to identify problems that crop up late in testing.

Item II-8 on T&E reporting format is related.

15. UPDATING OF IOT&E PLANNING

Periodically update military preliminary evaluation (MPE) and IOT&E planning during the early R&D phase.

Few missile system programs have had adequate user participation with the desirable continuity of personnel to minimize the problems of transition from DT&E to OT&E to deployment/utilization.

The MPEs may be largely restricted to mock-up exercises and user-evaluation participation in the R&D. One of the user-evaluator's major activity should be to use the day-by-day on-the-job training experience with the R&D system to assist in preparation of the IOT&E program for user command, support command, development command, and contractor guidance. A good IOT&E plan should cover the allocation of manpower spaces, assignment of personnel, personnel training, unit training, equipment provisioning including technical manuals, ground support equipment, spares and missiles, and launcher(s). The test plans may include instrumentation plans, ground tests, and flight tests of important profies. The data collection, analysis, and reporting schemes must be formulated.

The practicality of finding the right conditions for some of these tests during a reasonable IOT&E period may require some conditions to be simulated and possibly some to be deferred as goals for the follow-on OT&E. For example, cold weather test can only be conducted in the northern hemisphere in winter. Some winters are mild. A wait until the next winter for desired cold weather is probably not reasonable from the program standpoint. Simulation facilities, such as the Climatic Hanger at Eglin AFB, Florida can be used to provide reasonable assurance of the cold weather characteristics.

These user-evaluators involved in the MPEs and IOT&E should also prepare the follow-on OT&E plan. Since the follow-on OT&E is intended to be an indicator of operational suitability in the hands of a typical unit, the early user-evaluators should preferably be continued in the evaluator role instead of in the operator/maintenance activities.

16. INSTRUMENTATION PROVISIONS IN PRODUCTION MISSILES

Encourage built-in instrumentation provisions in production missiles.

In the more expensive missiles instrumentation leads can probably be built in with little cost or performance compromise. This is done in a recent ASM program. With these provisions, instrumentation can be added to more completely evaluate OT&E tests and other investigative tests on the operational systems such as searches for causes of troubles or in periodically monitoring life tests. Instrumented missiles, where feasible without compromising the operational character of the hardware, will provide much valuable data to help get maximum information out of each test.

Item II-3 on DT&E and IOT&E instrumentation is related.

17. CONSTRAINTS ON MISSILE OPERATOR

Detailed test plans should be evaluated to determine that the test imposed constraints on the missile operator do not invalidate the applicability of the data so collected.

The performance factor must be a major objective in any OT&E of the missile weapon system. Constraints such as requiring the operator to perform atypical functions (such as imposed by the test to collect data) may throw doubt on the validity of the data as it relates to weapon system effectiveness. On the other hand, realistic combat operator task loading should be included to the extent possible.

Item II-2 relates to human factor demonstrations in test planning.

18. PROBLEM FIXES BEFORE PRODUCTION

Ensure operational suitability tests identify operational deficiencies of new systems quickly so that fixes can be developed and tested before large scale production.

Operational tests should be used to identify problem areas associated with the tactics of delivering the missile system in realistic combat type conditions which can significantly degrade the operational effectiveness or utility of the weapon system. For example, an optically guided missile tracking subsystem may not function as desired for all sun angle conditions; semi-active laser guided seekers require reflected energy from the target, thus imposing possible constraints on the geometry of the designator, delivery system and the target. Human factor problems associated with displays, task loading and weapons delivery functions may restrict total capability of the system.

These problem areas need to be identified very early in the IOT&E phase so that possible engineering fixes can be studied, developed and tested prior to large scale production acquisition to allow for a more tactically usable missile. Furthermore, problem areas associated with human factors can be examined to determine special training requirements.

Item IV-6 is a reminder to emphasize fix testing not completed in IOT&E. Item IV-7 is also related and refers to OT&E feed-back to acceptance testing.

19. FLIGHT TESTS REPRESENTATIVE OF OPERATIONS

Ascertain that final DT&E system tests and IOT&E flight tests are representative of operational flights.

Some ballistic missile R&D programs have shown very high success rates in R&D flight test; however, when the early production systems were deployed, they exhibited a number of unsatisfactory characteristics such as poor alert reliability and poor operational test flight reliability. Be alert to conditions in the T&E that may give satisfactory R&D tests but result in poor operational experience. For example, in the R&D the maintenance equipment used to support the operational ground equipment (OGE) may be more sophisticated test gear than is used operationally. All R&D missiles may be launched using one set of highly tuned OGE. The use of one set or a small number of highly groomed ground systems may adversely affect the value of the relatively large number of successful R&D test flights.

Look for ways more effectiveness might result if different or additional things were done in R&D and IOT&E aimed at precluding the costly mods to correct early production deficiencies.

IV. SUBSTANTIAL PRODUCTION/DEPLOYMENT PHASE

This phase occurs after the DSARC substantial production decision. Follow-on OT&E will be conducted with production hardware. The test and evaluation checklist includes consideration of:

1. System Interfaces in Operational Test
2. Realistic Conditions for Operational Testing
3. Testing of all Operational Modes
4. Extension of OT&E for New Threats
5. "Lead-the-Fleet" Production Scheduling
6. Test Fixes from IOT&E
7. OT&E Feedback to Acceptance Testing

The reader should also review the checklist items in the previous phases, especially the last phase, since many of these items will be applicable during this phase.

1. SYSTEM INTERFACES IN OPERATIONAL TEST

Ensure the primary objective of an operational test is to obtain measurements on the overall performance of the weapon system when it is interfaced with those systems required to operationally use the weapons system.

Some missile systems, such as ICBMs, are usually a complete system developed by one project office and an operational test would be difficult to even try without using the whole system, with the possible exception of part of the C^3. On the other hand, some of the tactical systems must operate from several different carriers and some can be used in a direct mode, where the target is acquired from the carrier before missile launch, and some can be used in the indirect mode, where the target is selected by a second party and the missile acquires after launch. An operational test for overall performance of a tactical missile system used in a direct fire mode should include (as a function of target type, terrain, weather, tactics, etc.):

- Readiness (measured by maintainability, supportability, alert reliability, etc.)
- Target acquisition capability in terms of range and probability
- Missile launch capability in terms of range and probability
- Survivability of the launcher and the target designator
- Total probability of target kill.

Testing of terminally guided missiles used in an indirect fire mode must also provide data on the accuracy of location of the target and the capability to launch the missile into the necessary basket in order for the terminal guidance to be operative. In addition, the communications between the designator and the launcher are important.

2. REALISTIC CONDITIONS FOR OPERATIONAL TESTING

Ascertain operational testing is conducted under realistic combat conditions.

This means that the offense/defense battle needs to be simulated in some fashion before the evaluation of the weapon system can be considered completed. Whether this exercise is conducted within a single service (as in the test of a surface-to-surface anti-tank missile against tanks) or between services (as in the test of an air-to-surface missile against tanks with anti-aircraft protection), the plans for such testing should be formulated as part of the system development plan.

Special attention should be placed on the realistic environment to be used in the operational test, on the vulnerability of the various elements of the missile system (FAC, platform, target designator, etc.) and on the use of models and simulators to evaluate the post launch activities affecting target kills (probability of break lock of the missile, reliability, invalid launches, etc.) when the missile is not launched during tests.

Similarly, the OT&E offense/defense tests should be performed in appropriate weather. Ballistic missiles and their ground systems should be tested under extremes of weather. The tests should include the launch control center, the communications, and the launcher, whether it be a silo, a submarine, or any other. The value of this was demonstrated by one system that was deployed for some time before it was discovered, one winter day, that a silo wouldn't open due to an ice and snow condition. It may also be reassuring to know that a missile had been successfully test launched through a thunderstorm or a heavy sea. The practicality of finding the right conditions for some of these tests during a reasonable IOT&E may require some conditions to be simulated and possibly some to be deferred as goals for the follow-on OT&E. In summary, the goal is that the full production equipment should be tested under appropriate offense/defense, day/night, weather conditions.

Item I-6 covers preliminary test plans for offense/defense testing.

3. TESTING OF ALL OPERATIONAL MODES

Assure the follow-on OT&E plan includes tests of any operational modes not previously tested in IOT&E.

All launch modes, included degraded, backup modes, should be tested in the follow-on OT&E because the software interface with the production hardware system should be thoroughly evaluated, otherwise small, easy to fix problems might preclude launch. To do this might cause extension of the R&D/IOT&E phase because of the operational flexibility of some ballistic missiles, particularly those with MIRV options or MIRV/PENAID combinations.

Item III-2 states that tests should be conducted to evaluate all operational flight profiles and all primary and back-up degraded operating modes in the DT&E and IOT&E.

4. EXTENSION OF THE OT&E FOR NEW THREATS

Be alert to the need to extend the OT&E if a new threat shows up.

Very few missile programs perform any kind of tests relatable to evaluating system performance against current threats, let alone new threats. It is important to ensure that adequate testing is carried out against current threats and that the T&E function be responsive to new threats, should they be identified later.

The operational test should be re-instituted to evaluate system adequacy in the face of new threats encountered after the system is operational and the first follow-on OT&E phase is complete. The continuing test activities that usually generate reliability and CEP data for war plan purposes, should be considered also as a source of test resources for testing responses to new threats.

5. "LEAD-THE-FLEET" PRODUCTION SCHEDULING

"Lead-the-Fleet" missile scheduling and tests should be considered.

In almost every missile program there are items which have limited shelf life or have caused performance variations as a function of age.

A missile's peacetime life will consist of storage checkouts and, for ASMs most of their life will be spent hanging on an aircraft on the ramp plus several hundred hours of being carried on an airplane in flight. Some of the earliest pilot production missiles should be devoted to "lead the fleet" for reliability and life tests. These ASMs should be required to accumulate many more ramp exposure hours and captive flight hours than usual prior to launch.

A propulsion life test program should be set up early in the production phase of any rockets. A selected number of propulsion states from each production block should be set aside for long-time storage under environmental conditions simulating those to which the operational missiles are exposed. These motors would be inspected periodically as the operational life expectancy is reached or if propulsion aging problems appear earlier, these motors provide a test sample for firing demonstration.

Safe and arming (SAF) systems which contain chemical igniters should similarly be set aside for aging tests. Any detonators used in thrust termination blow-out parts, explosive bolts used in stage separation, or similar chemical systems that might deteriorate should also be set-up for a life assurance monitoring program.

In this fashion, T&E on production "lead the fleet" missiles can provide early indications of problem areas and possibly preclude dangerous situations or stand-downs of important capabilities.

6. TEST FIXES

Test fixes resulting from earlier operational testing.

Following initial operational tests which identify problem areas in missiles, follow-on OT&E should be alert in these areas with the primary intent of investigating the adequacy of the fixes incorporated, particularly if the IOT&E did not run long enough to test the fixes. For example, on one program a rocket nozzle deficiency showed up in a ground qualification test of a motor just at the end of the equivalent of IOT&E testing. Fixes were developed and ground tests, but extensive full system flight tests with were developed and ground tests, but extensive full system flight tests with the fixed nozzle had to await follow-on OT&E.

Item III-18 addresses the desirability of finding and fixing such problems in IOT&E. Also see IV-7.

7. OT&E FEEDBACK TO ACCEPTANCE TESTING

Ensure OT&E results are quickly fed back to influence early production acceptance testing.

Production acceptance testing is probably the final means the government will normally have to ensure the product meets specifications. That early acceptance testing could be influenced favorably by a quick feedback from follow-on OT&E to acceptance testing is exemplified by a current ASM program where production has reached peak rates and the OT&E has not been completed.

Items III-18 and IV-6 are related.